

Of Moss and Men



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THE
MOSSBUSTERS

Who ya gonna call?

(425) 772-7055

- Roof Cleaning
- Gutter Cleaning
- Pressure Washing
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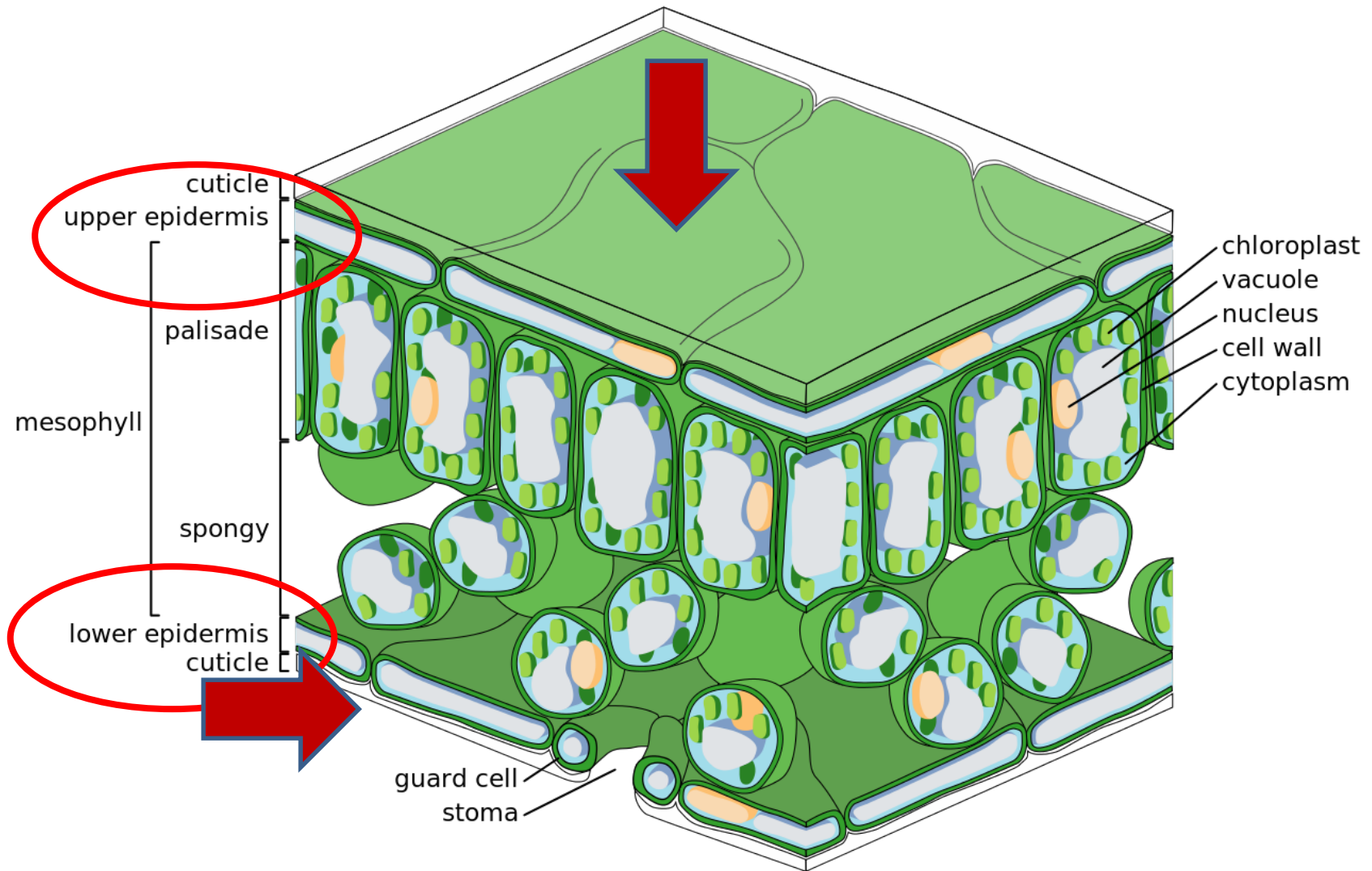
What is a moss?

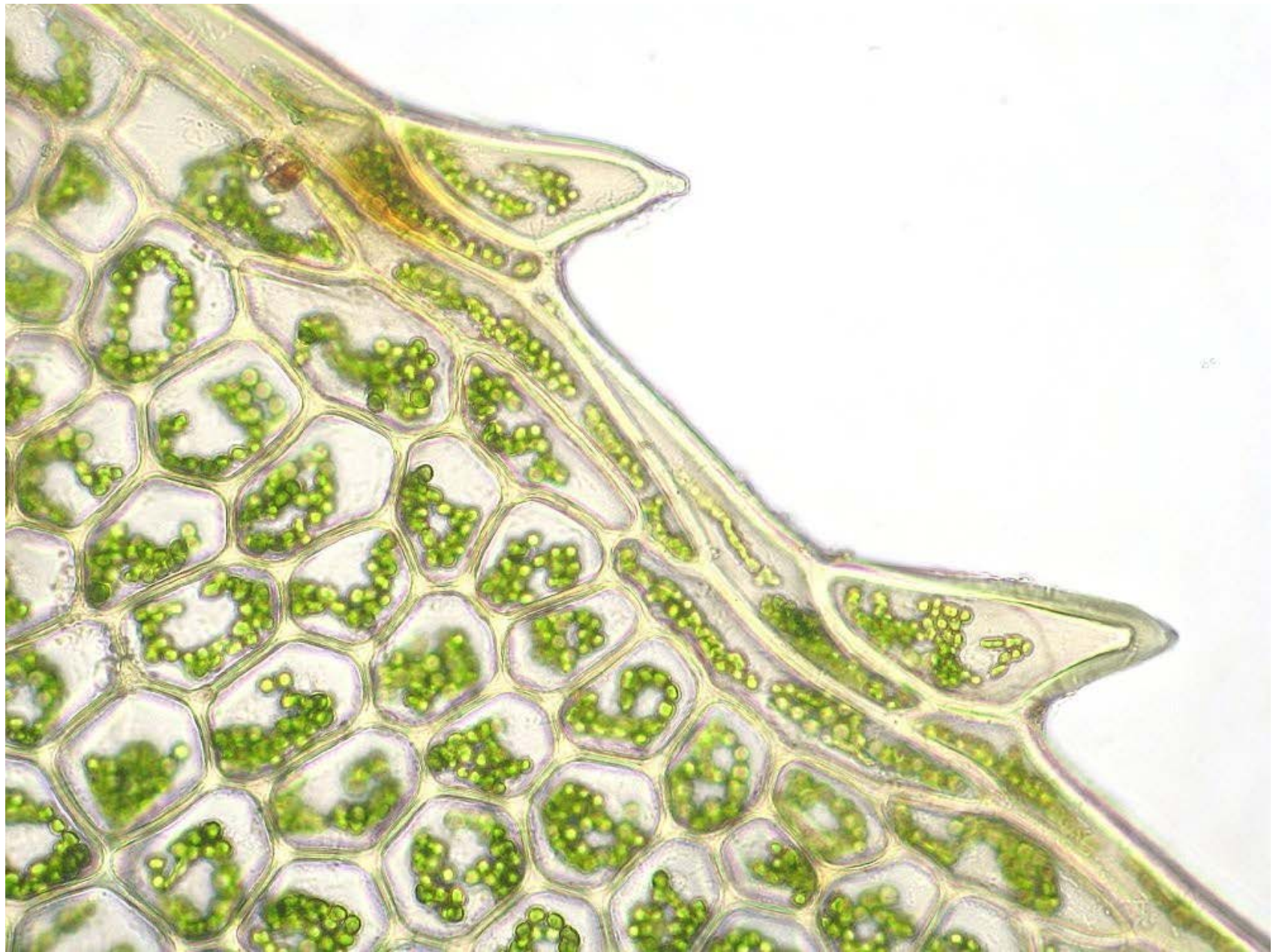
Definition: taxonomic division *Bryopsida*
small, non vascular plants
the oldest plant lineage...





Vascular plant leaf in cross-section





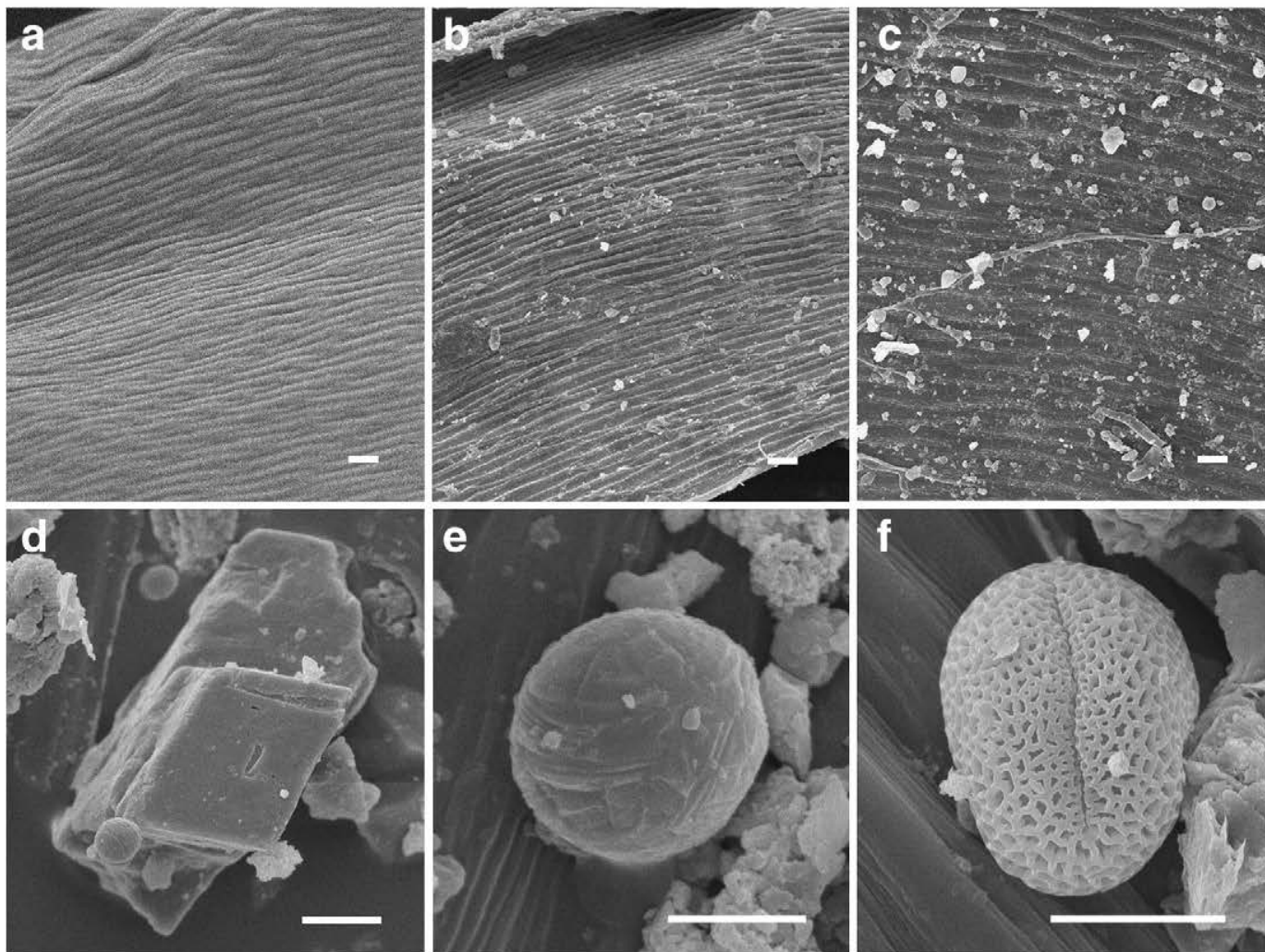
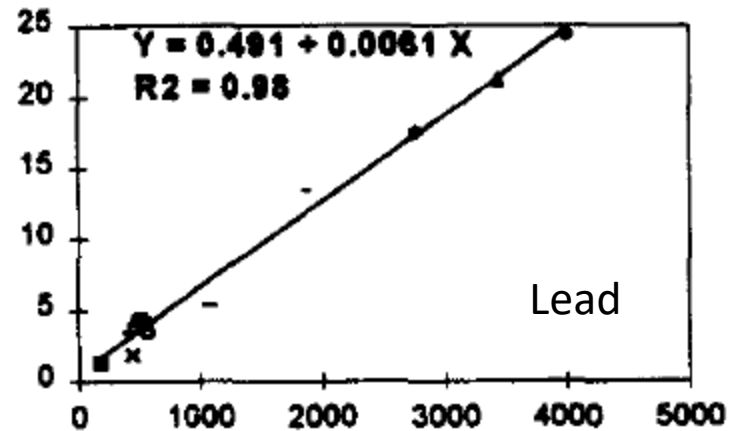
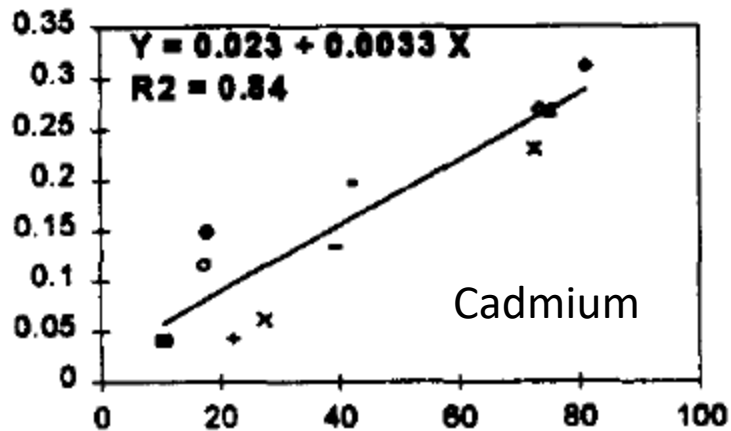
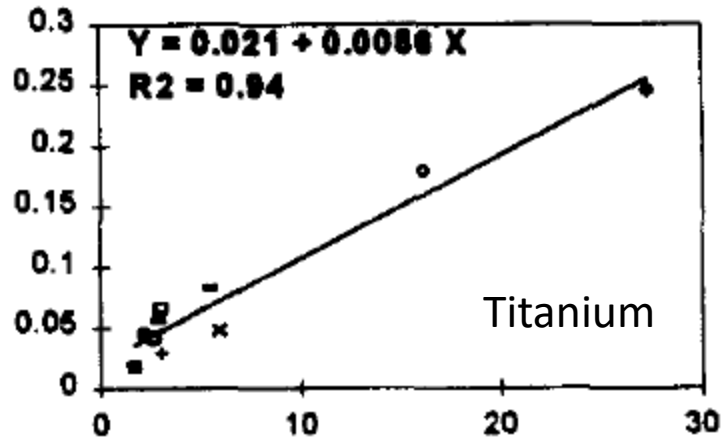
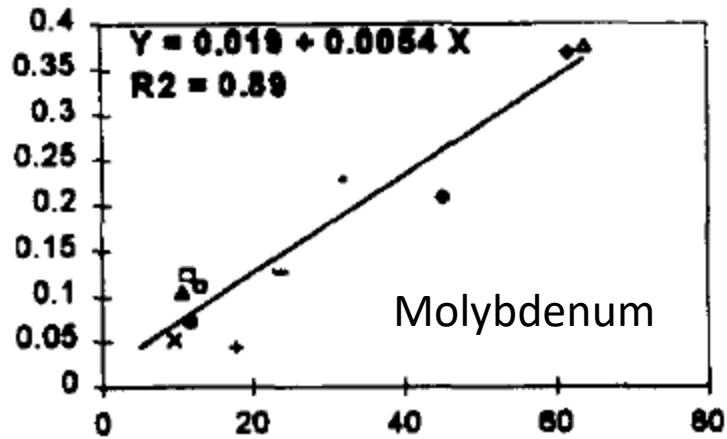


Fig. 5. SEM micrographs of moss leaflets before (a) and after exposure (b,c) in the green (b) and roadside (c) site pair nr. 9 of Fig. 1, and enlargement of particulate matter (d,e) and pollen grain (f). Bar = 10 μm (a–d, f); 3 μm (e).

Concentrations ($\mu\text{g g}^{-1}$) in *H. splendens*



Wet deposition ($\mu\text{g m}^{-2}$)

Why use bioindicators?

Expense per site

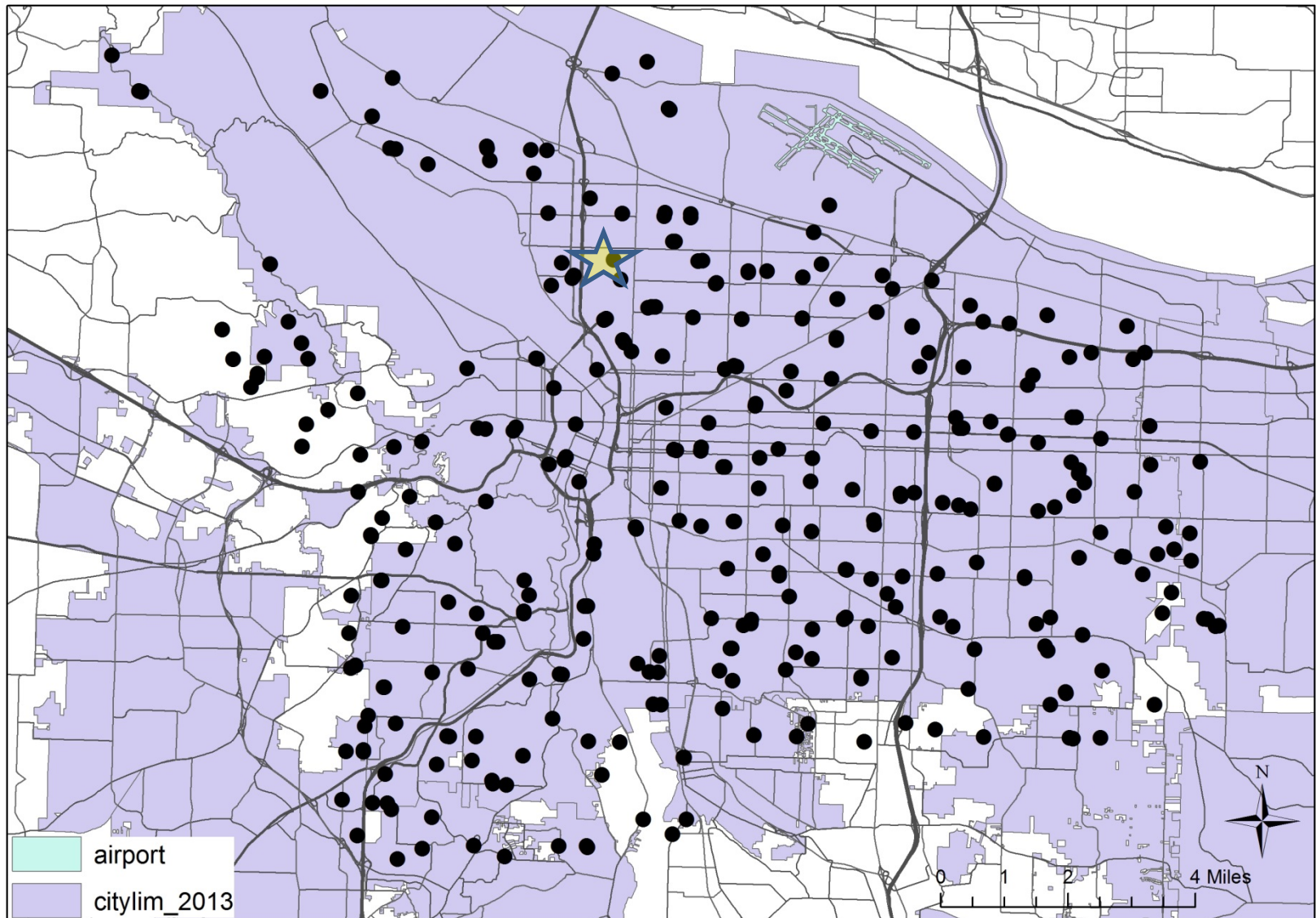
Air Q active instruments: ~\$100K-150K (annually)

Moss: ~\$150



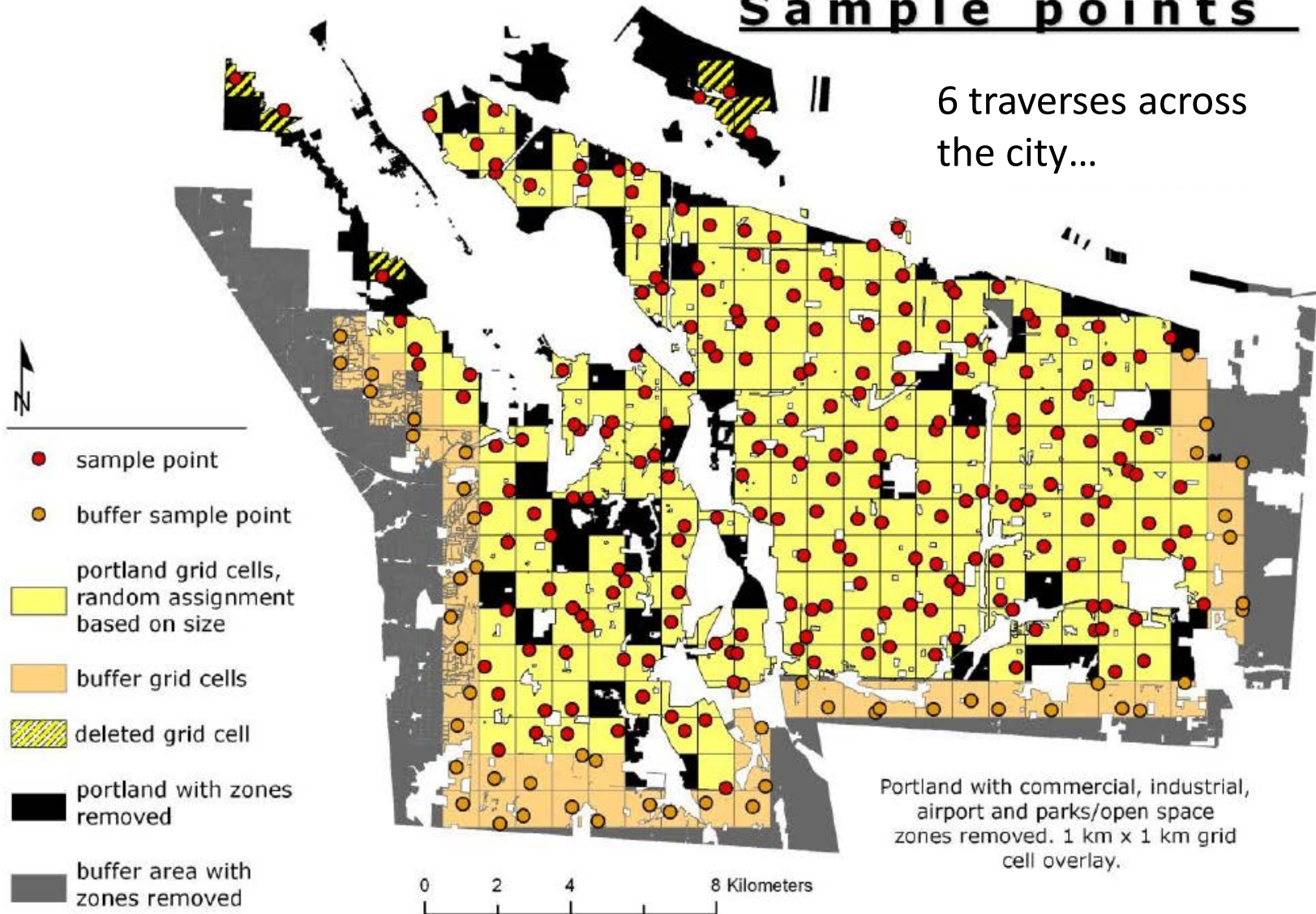
Moss samples = 346 in 2013

★ Air quality monitors = 1



Sample points

6 traverses across
the city...

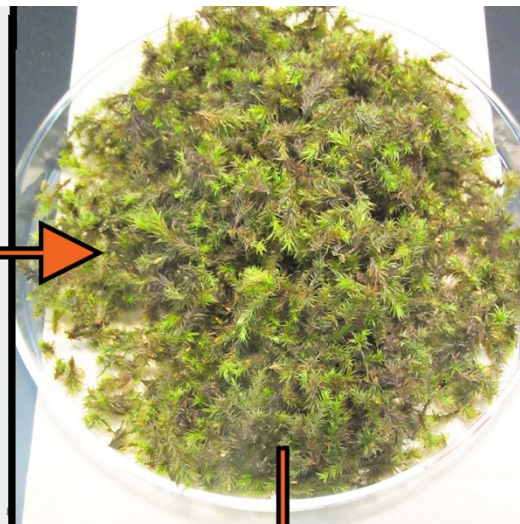




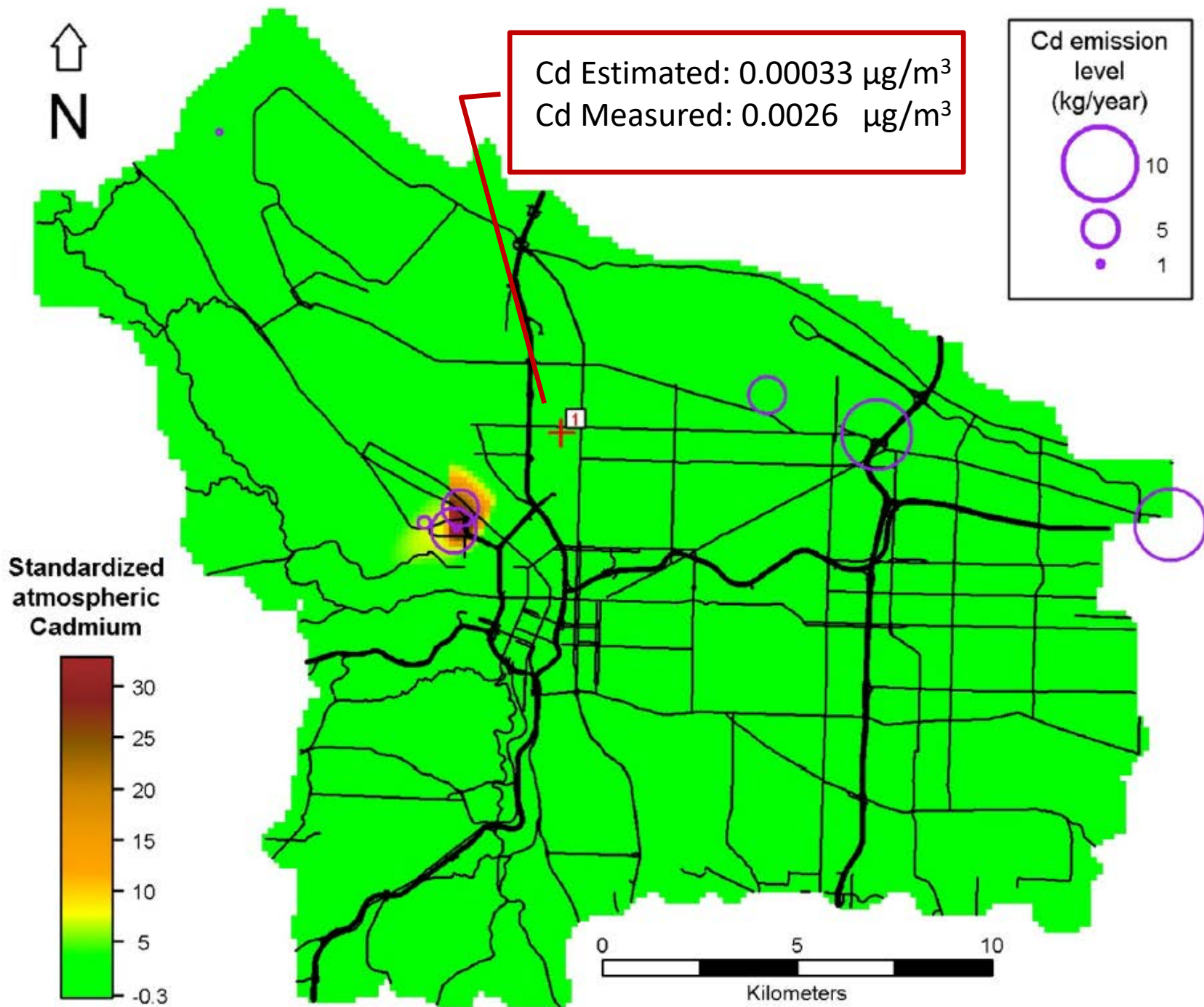
Orthotrichum lyellii

U.S. distribution: AK, CA, ID, OR, WA





Analysis by ICP-OES:
Al, As, B, Ba, Ca, Cd,
Co, Cr, Cu, Fe, K, Mg,
Mn, Mo, Na, Ni, P,
Pb, S, Se, Si, Sr, Zn



Cadmium (Cd):

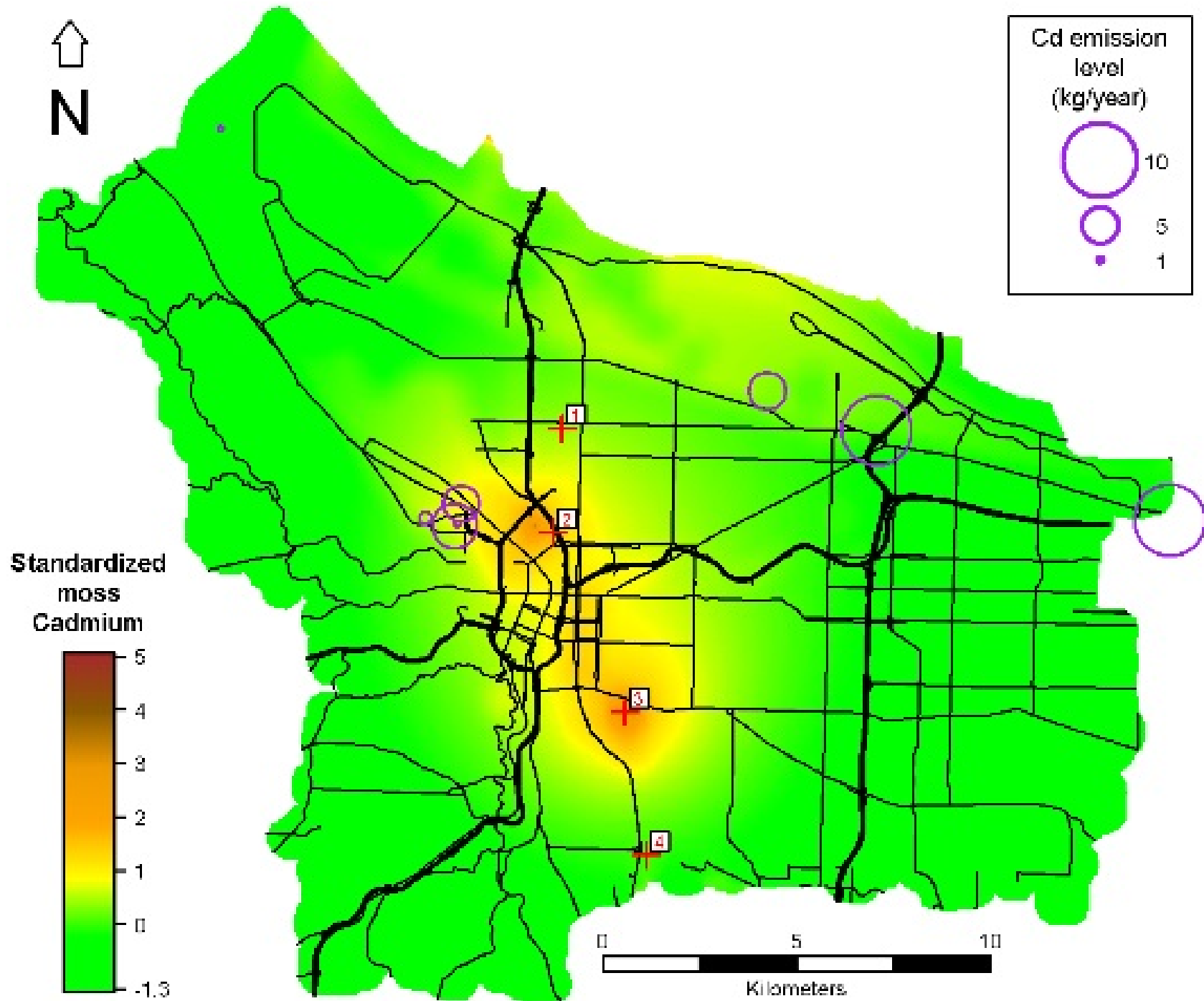
- Lung cancer
- Prostate cancer
- Kidney disease
- Learning difficulties in children
- For more info, see ATSDR Cas ID# 7440-43-9

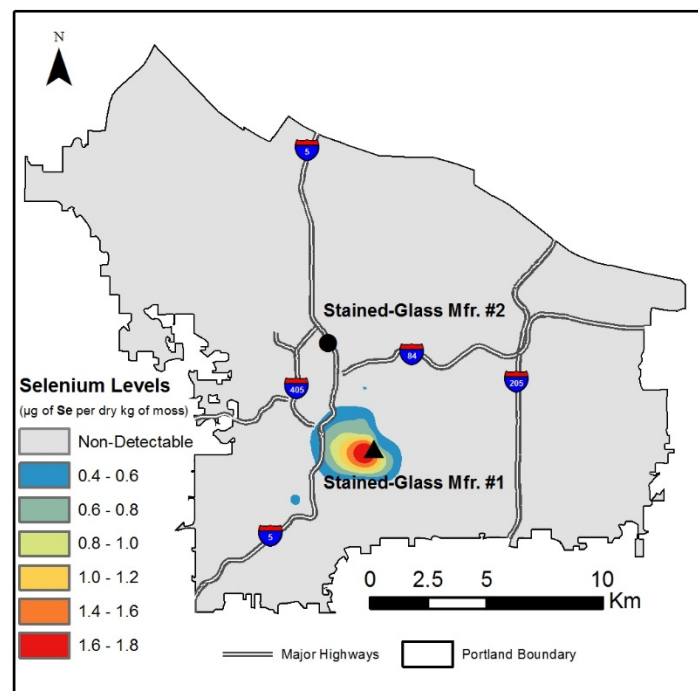
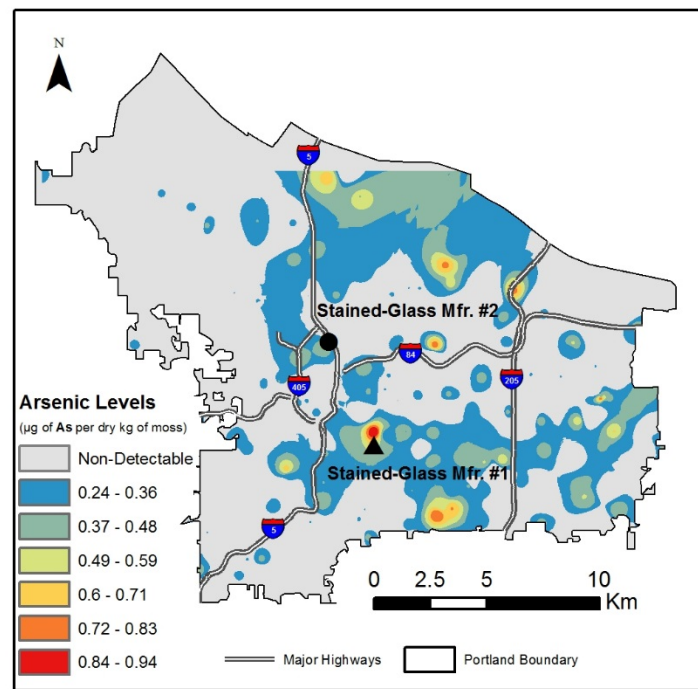
Spatial modeling

- Built a spatial linear model of $\text{Ln}(\text{Cd})$ in moss using an exponential covariance structure
 - Backwards, step-wise model selection
 - Models estimated using restricted maximum likelihood (SAS 9.4 MIXED)
- Used final model to estimate Cd on a 50m grid across the city

Covariates

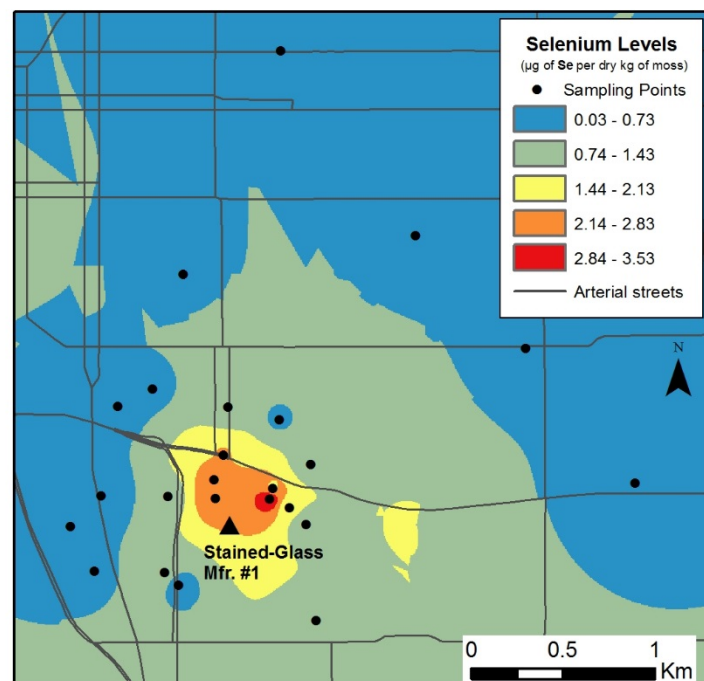
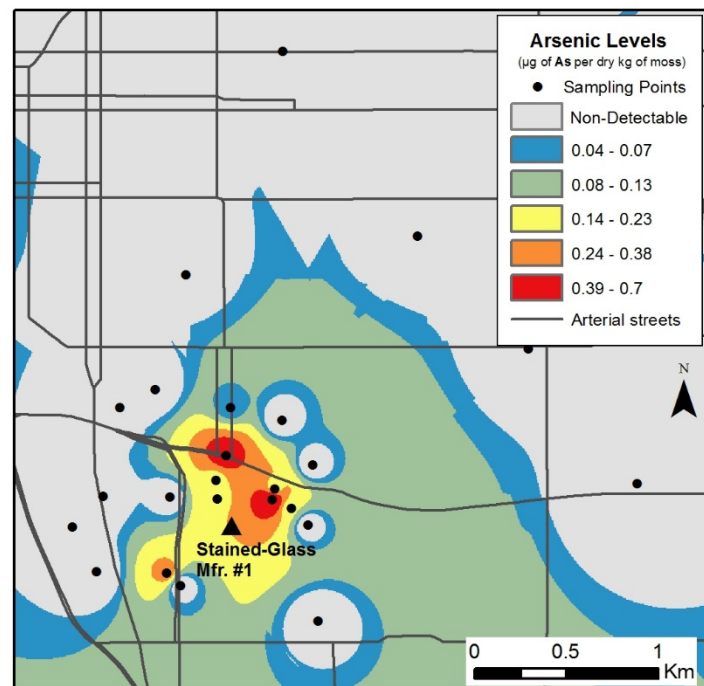
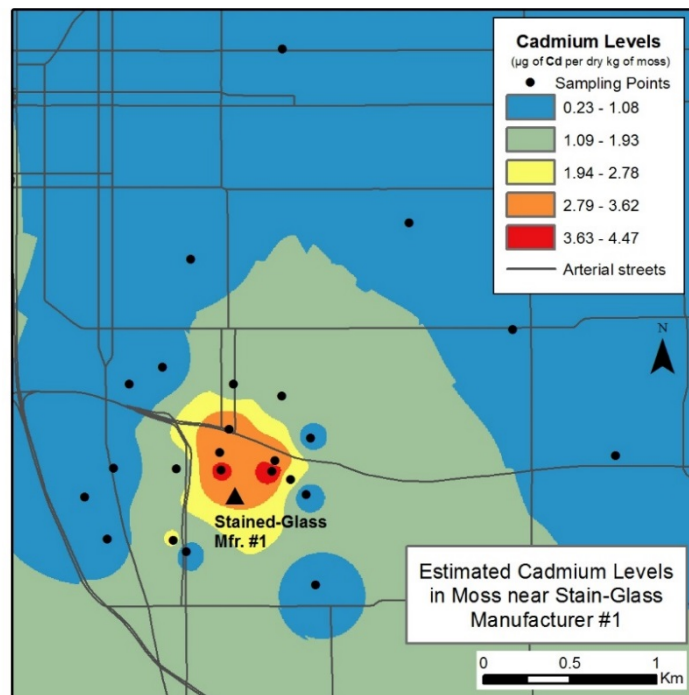
- Tree genus
- Weather (precipitation, temperature)
- Density of roads (IDW, 500m buffer)
- Tree canopy cover (IDW, 500m buffer)
- Distance to permitted Cd emitters
- **Distances to 2 unpermitted glass factories**
- **Distance to Washington border**
- **Percent industrial land (500m)**
- **Percent residential land (500m)**

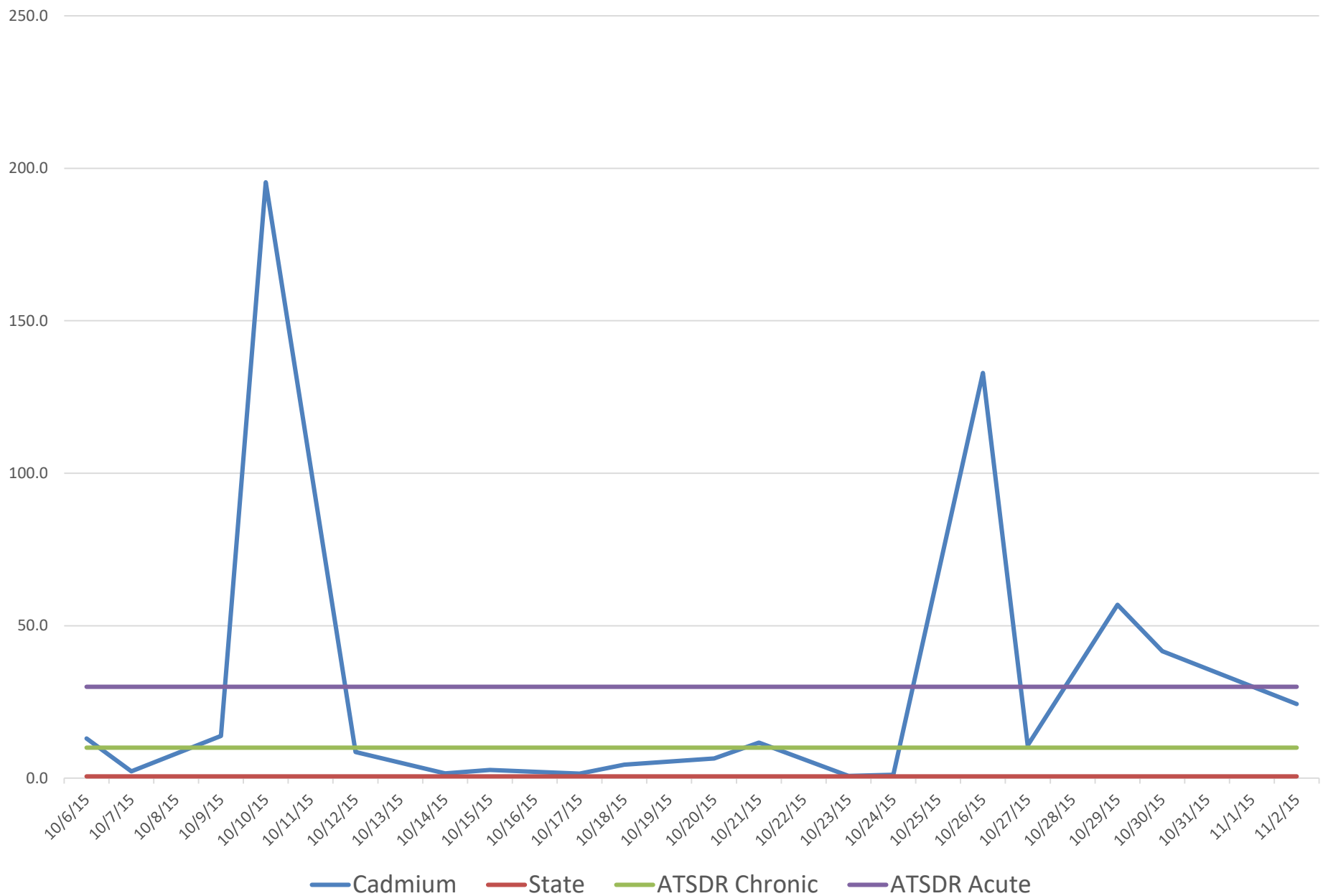




- Informed DEQ of findings
- DEQ monitored air near the facility in Oct 2015
- Oct 2015, We sampled 25 additional sites in the area with the help of a PSU Urban Ecology class







Area of concern



- Neither facility was out of compliance with the law....
 - Both glass facilities voluntarily stopped using Cd, As, Cr
 - Air concentrations dropped precipitously
- Found a regulatory loophole “the size of a lunar crater.”
 - Glass facilities with “intermittent” furnaces not required to filter particulates (EPA exemption).
 - Baghouses (used by glass facilities with Cd permits) filter out ~99% of particulates

Resolution?

- DEQ and EPA closing the loophole
 - investigating other 'exempt' glass factories
- Gov. Brown's 'Cleaner Air Oregon'
 - 2.5mil increase for DEQ
 - DEQ to develop and enforce health risk-based regs for all industries
 - DEQ to employ moss monitoring
- Wyden/Merkeley funding request
 - 38mil for EPA, expand toxics monitoring (inc. moss monitoring)
 - 18.6mil for the Agency for Toxic Substances and Disease Registry (ATSDR)



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Next steps:

- Metals GTR
 - To publish data on the remaining 21 elements we measured.
- Reciprocal transplant study with PSU
 - To help us learn what timeframe metals in the moss represents
- CALIBRATION!
 - Pairing moss data with DEQ particulate monitors to determine accuracy of the moss
- Cincinnati, summer 2017
 - Map metals and compare with neuroimaging data from the Cincinnati Children's Hospital